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# Ventilation practices and preparedness of healthcare providers in term newborn resuscitation: A comprehensive survey study in Austrian hospitals

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## ABSTRACT

**Aim of the study:** Although neonatal resuscitation is rare, and high-risk births usually occur in specialised centres, unexpected resuscitation measures may be necessary during births that are initially considered low-risk. This survey assessed the practices of healthcare providers in Austrian hospitals for postnatal resuscitation and evaluated their self-assessed airway management skills for newborns.

**Methods:** An online survey was distributed to all staff members responsible for the postnatal care of newborns in hospitals with obstetrics in Austria through the heads of departments (paediatrics, obstetrics, and anaesthesiology). The results are presented in terms of hospital care level and birth volume.

**Results:** In total, 79.5 % of all hospitals with maternity units in Austria participated in the survey. Preparedness was found to be improved with the level of care provided by the hospital. Overall, 50.4 % of the respondents did not feel adequately prepared for neonatal emergencies, and 35.0 % rated their face mask ventilation skills as insufficient. According to the survey results in 61.3 % of included hospitals or 52.5 % of births in Austria, safe endotracheal intubation cannot be provided.

**Conclusion:** A significant proportion of healthcare workers in Austria responsible for postnatal newborn care do not feel adequately prepared for newborn emergencies.

## Introduction

Neonatal emergencies occurring directly after birth are rare,<sup>1</sup> and the risk factors for potentially impaired newborns are known.<sup>2</sup> In Austria, as in many other countries, hospitals are stratified by care level to ensure that potentially critically ill newborns are assigned the highest level of prenatal care.

However, unexpected newborn emergencies may occur, necessitating immediate support or resuscitation measures for neonates after birth.<sup>3–5</sup> Therefore, the current European Resuscitation Council (ERC) newborn life support (NLS) guidelines require that all institutions where deliveries may occur be prepared for unexpected emergencies immediately after birth.<sup>2</sup>

Nevertheless, owing to the rarity of postpartum resuscitation events, especially for staff in hospitals with lower levels of care, it is difficult to gain sufficient experience in newborn emergencies through clinical work alone. To comply with the requirement for competent personnel at

every delivery, the ERC NLS guidelines suggest implementing 'structured educational programs teaching the knowledge and skills required for newborn resuscitation', ideally conducted more frequently than once per year.<sup>2</sup>

Currently, there is no data confirming whether essential skills outlined in the NLS guidelines (e.g., effective ventilation or endotracheal intubation [ETI]) can be consistently ensured in low-level hospitals, as most evidence is derived from larger perinatal centres.

Therefore, our survey aimed to investigate whether these essential skills can be expected at all levels of care in the Austrian healthcare system. Therefore, we analysed the hospital staff's subjective self-assessment of their preparedness for neonatal emergencies and airway management skills across various professions responsible for the stabilisation and resuscitation of term newborns. The results were presented in relation to hospital care levels and birth volumes in Austria. Additionally, assessments of current controversial topics in neonatal resuscitation were gathered and discussed.

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## Methods

### Design and sample

An anonymous survey was designed comprising 17 questions on ventilation practices in newborn resuscitation, self-assessment of various ventilation skills, and other topics related to neonatal resuscitation that are subject to controversial debate. The survey was tested by three neonatal consultants, and the questions were modified based on their feedback. The final questionnaire (Table S1) was then distributed electronically (via e-mail) to the heads of the neonatal, paediatric, obstetric/gynaecological, and anaesthetic departments in all hospitals in Austria with obstetric departments (n = 78). All heads of department were requested to distribute the questionnaire to the staff members involved in the postnatal care of newborn infants. They were approached at least twice during the study period (from September 2022 to May 2023).

We assigned randomly generated IDs to surveys from each hospital to indicate the level of care provided. The number of births indicated for the different levels of care was calculated combining data of the Nutricia birth survey 2022 (Danone GmbH, Austria) and data from the Vienna Hospital Association (Vienna, Austria).

### Data analysis

Descriptive statistics were used to interpret the data. Further statistical analyses were performed using RStudio 2021.09, employing R v4.1 (R Core Group, Vienna, Austria). Hence, we transformed the Likert-scale responses to binary data (e.g. 'sufficient' and 'not sufficient'); for example, the 5-item response scale in 'How well-prepared do you feel for neonatal emergency situations?' (question 5) were transformed into the categories 'sufficient' (4 or 5 on 5-item scale) and 'not sufficient' (1 or 2 or 3). Similarly, on the 7-item response scale of Question 17, we used 'sufficient' (5, 6, or 7 on a 7-point Likert scale), 'not sufficient' (ratings of 2, 3, or 4) and 'never used this device' (rating of 1, separate category in Fig. 2B) categories, which we assumed would also result in an insufficient skill.

Questions on the use of ETI and laryngeal masks (LMAs) were administered to a subset population including only anaesthesiologists, paediatricians, and neonatologists (airway group).

We employed Fisher's exact test to identify differences in the binary data based on various demographic factors (e.g. hospital level and profession). Next, we assessed statistical significance using pairwise Fisher's exact tests with Bonferroni correction for multiple comparisons to identify within-demographic differences.

Ethical approval was not required for this study, as determined by the Austrian Ethics Committee, due to the anonymous and non-traceable nature of the nationwide survey.

**Table 1**  
Demographics of participating hospitals.

Grouping Factor	Category	Austrian Classification	Hospitals in Austria	Included hospitals n (%)	Responses n (% of all responses)
Hospital Level	Level IV*	Center of Perinatal Medicine**	7	7 (100 %)	51 (13.5 %)
	Level III*	Category A**	8	6 (75 %)	21 (5.6 %)
	Level II*	Category B**	16	13 (81 %)	104 (25.7 %)
	Level I*	Basic Care**	47	36 (76 %)	201 (53.3 %)

\*According to Austrian classification of levels of care.

\*\*Austrian Classification of levels of care:

Level I = Basic Care = Neonates from GA 36 + 0 onward, no neonatal department.

Level II = Category B = General hospital, neonatal intermediate care.

Level III = Category A = Neonatal intensive care.

Level IV = Center of Perinatal Medicine = Neonates of all ages, neonatal intensive care.

## Results

### Demographics

Of the 78 hospitals with obstetrics in Austria, 62 hospitals responded (79.5 %), with 377 returned surveys (Tables 1 and 2).

#### Individual overall preparedness: How well-prepared do you feel for neonatal emergency situations?

Of all survey participants, 49.6 % (187 of 377) felt sufficiently prepared for neonatal emergency events, while 50.4 % (190 of 377) did not feel sufficiently prepared. The preparedness rating was associated with an increasing level of hospital care ( $p < 0.001$ ; Fig. 1), with participants from Level IV hospitals showing significantly higher preparedness than those from any other hospital level. Similarly, the participants' profession was also a crucial factor level of preparedness ( $p < 0.001$ ; Fig. 2). Neonatologists felt better prepared than any other profession, followed by anaesthesiologists and paediatricians.

In Austria's Level I and II neonatal care units, which account for 64.5 % of all births in the country, 57.4 % of the responsible medical staff reported feeling inadequately prepared for neonatal emergencies.

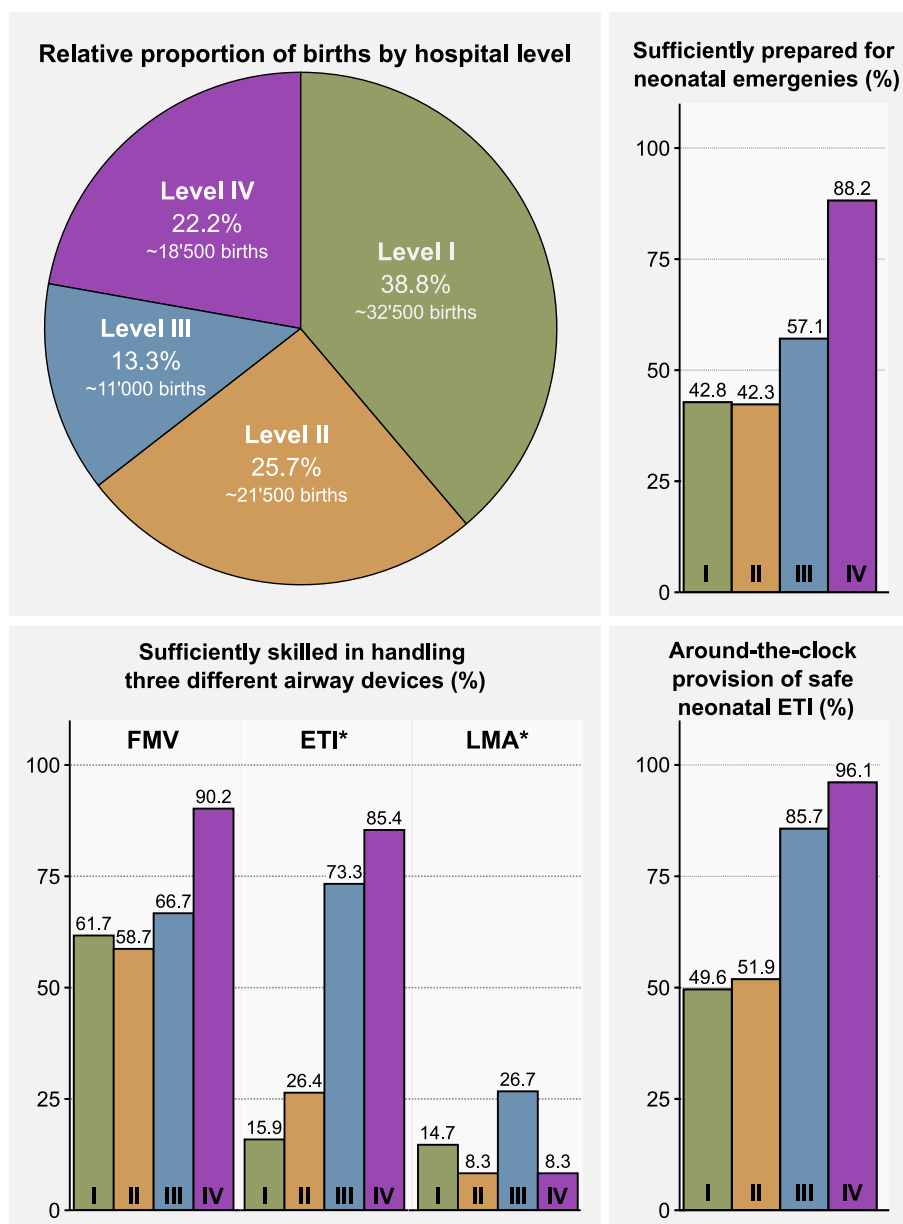
#### Individual skills: Rate your skills in the airway methods face mask ventilation (FMV), endotracheal intubation (ETI), and laryngeal mask airway (LMA)

##### a. Individual FMV skills

In total, 65.0 % (245 of 377) of the survey population rated themselves as having sufficient FMV skills. A difference between hospital levels was detected ( $p < 0.001$ ) with level IV showing significantly more 'sufficient' ratings (90.2 %) than those of the lower hospital (levels I and II) (Fig. 1; Table 3). Furthermore, differences in preparedness were observed on basis of professions (Fig. 2;  $p < 0.001$ ); neonatologists were

**Table 2**  
Participant demographics.

Profession	Anaesthesiologist	89 (23.6 %)
	Neonatologist	57 (15.1 %)
	Obstetrician/Gynaecologist	65 (17.2 %)
	Paediatrician	84 (22.3 %)
	Midwives	40 (10.6 %)
	Nurses	21 (5.6 %)
	General Medicine	14 (3.7 %)
	other	7 (1.9 %)
Experience	<2 years	82 (21.6 %)
	2–5 years	75 (19.9 %)
	6–10 years	51 (13.5 %)
	11–20 years	88 (23.3 %)
	>20 years	81 (21.5 %)



**Fig. 1.** Information for each level of care based on data from this survey study is displayed in the pie chart (number of births stratified by hospital level in Austria) and the bar plots. The colours correspond to the hospital levels shown in the pie chart. Asterisks indicate responses from the airway group.

the only professions that felt sufficiently prepared (100 %).

**b. Individual ETI abilities (airway group)**

We investigated the ETI skills of the subset airway group. Less than half of this group rated themselves as having sufficient newborn ETI skills (44.8 %, 103 of 230). Similar to FMV, a significant difference was found between hospital levels ( $p < 0.001$ ). Level III and IV hospitals had significantly higher scores than those of Level I and II. The difference between professions was also significant ( $p < 0.001$ ); neonatologists showed significantly higher ratings than other professionals (Figs. 1 and 2; Table 3).

**c. Individual LMA abilities (airway group)**

A majority of the respondents never used LMA on a newborn (74.3 %, 171 of 230) and a small proportion (12.2 %, 28 of 230) rated themselves as proficient in LMA. Across professions, only a few rated their skills as

‘sufficient’ (Fig. 2). Anaesthesiologists showed the highest percentage of ‘sufficient’ LMA skill ratings for newborns (20.2 %, 18 of 89). No significant differences were found between hospital levels (Fig. 1) or profession.

Additional information on the use of different airway devices is provided in Tables 3 and Table S2.

*Facility preparedness: Does your facility provide safe neonatal ETI (i.e. an expert who can safely deliver ETI) 24/7 (including emergency situations)?*

Less than two-thirds (58.6 %, 221 of 377) of the respondents stated that safe ETI could be provided at all times in their facility. As expected, perceived facility preparedness was lower at more basic care levels (Fig. 1).

Facility preparedness was analysed individually for each hospital, and in 24 of the 62 hospitals (38.7 %), only positive answers to this question were provided, indicating that ETI would likely be safe in these facilities 24/7.

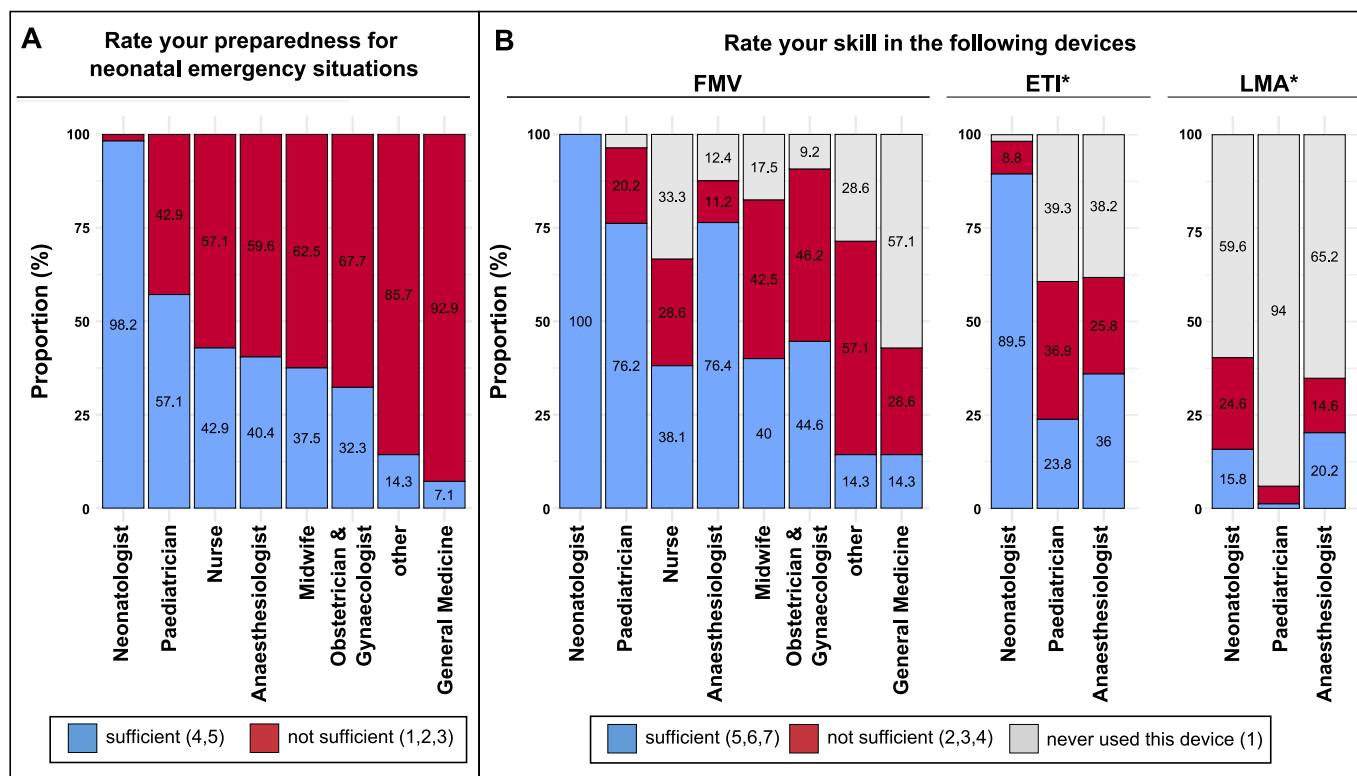


Fig. 2. Self-rated A) preparedness for neonatal emergency situations, B) skills with different ventilation devices in terms of profession. Blue colour indicates 'sufficient' scores; red, 'not sufficient' scores; grey, proportion of participants who never used the respective device in airway management. Asterisks indicate that only responses from the airway group are displayed. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Adding the number of births per year to these hospitals showed that 24 hospitals with a total of 33.307 births per year could safely perform ETI 24/7 (47.5 % of all births in Austria), and 38 hospitals with 36.750 births (61.3 % of hospitals or 52.5 % of all births) could not feature safe intubation around the clock. The remaining 14.742 births from hospitals that were not included in our study were excluded from this analysis.

*Controversy point: Which problems do you perceive exist when performing [FMV, ETI, LMA] on a newborn baby?*

For FMV, the mask seal and airway obstruction (head positioning during ventilation) were the most frequently mentioned challenges.

The primary issues associated with ETI were insufficient experience and training, complicated neonatal anatomy, fear, stress, and potential harm due to limited sight.

For LMA, the lack of experience and training possibilities stood out as the most pressing issue, followed by positioning problems and the unavailability of LMAs in the department.

*Controversy point: What is the first ventilation tool you would use on a term newborn that requires respiratory support immediately after birth?*

We offered six options for devices (round masks, anatomically shaped face masks with an air rim, ETI, binasal prongs, laryngeal masks, and pharyngeal tubes). Anatomically shaped face masks with air rims were preferred by the majority (74.9 %, 288/377) of the participants, followed by round masks (21.8 %, 82/377). Three participants selected binasal prongs; one, ETI; three, 'could not say'.

*Controversy point: In the context of neonatal resuscitation, what priority would you give to intubation, assuming mask ventilation is effective?*

Assuming that mask ventilation is effective, 80.0 % (184 of 230) of the respondents in the airway-group (anaesthesiologists, paediatricians and neonatologists) considered 'ETI only after chest compressions' and 'establishing vascular access for drug administration'. 'ETI before vascular access' was preferred by 13.9 % (32 of 230) respondents. In 6.1 % (14 of 230) of cases, 'ETI prior to the administration of chest compressions' was preferred. Thirteen of the 14 respondents rated themselves as 'sufficient' for neonatal ETI.

## Discussion

In this survey study, we analysed emergency preparedness and individual self-assessment of newborn airway skills among Austrian healthcare providers engaged in the postnatal care of newborns. With a substantial participation rate (respondents from 62 of 78 hospitals in Austria), we obtained a statistically representative result. The findings were reported separately for different neonatal care levels and contextualised with the annual birth rates at the respective medical facilities.

### Preparedness

Despite known risk factors,<sup>2</sup> one in every 200 low-risk term newborns in high-resource countries unexpectedly requires intervention<sup>3-5</sup> Therefore, adequate preparation (regular training, optimal equipment/infrastructure, and sufficient personnel) is essential at all levels of care.

In this survey, only 49.6 % of the respondents, particularly from hospitals with higher levels of care, felt adequately prepared for newborn emergencies. Increased frequency of care for high-risk infants

**Table 3**

Application and skill sufficiency details of the three ventilation devices. Asterisks(\*) indicate that the information is based on the airway group (230 replies).

	Overall	Level I	Level II	Level III	Level IV	Anaesthesiologist	Neonatologist	Paediatrician	Ob/Gyn	General Medicine	Midwife	Nurse	other
n	377 (*230)	201 (*95)	104 (*72)	21 (*15)	51 (*48)	89	57	84	65	14	40	21	7
FMV applied to newborn in last 6 months	66.60 %	58.20 %	73.10 %	52.40 %	90.40 %	53.90 %	93.00 %	92.90 %	55.40 %	21.40 %	52.50 %	38.10 %	42.90 %
ETI applied to newborn in last 6 months*	33.50 %	9.50 %	22.20 %	53.30 %	91.7 %	5.60 %	71.90 %	36.90 %	0	0	2.5 %	0	0
LMA applied to newborn in last 6 months*	3.90 %	1.10 %	4.20 %	0	10.40 %	1.10 %	8.80 %	3.60 %	0	0	0	0	14.30 %
administered FMV to newborn more than 10 times	24.80 %	10.50 %	16.70 %	40.00 %	60.40 %	10.10 %	70.20 %	9.50 %	0	0	0	0	0
administered ETI to newborn more than 10 times*	1.70 %	2.10 %	1.40 %	0	2.10 %	3.40 %	0	1.20 %	0	0	0	0	0
administered LMA to newborn more than 10 times*	65.00 %	61.70 %	58.70 %	66.70 %	90.20 %	76.40 %	100 %	76.20 %	44.60 %	14.30 %	40.00 %	38.10 %	14.30 %
ETI skill sufficient*	44.80 %	15.90 %	26.40 %	73.30 %	85.40 %	36.00 %	89.50 %	23.80 %	0	0	0	0	0
LMA skill sufficient*	20.20 %	14.70 %	8.30 %	26.70 %	8.30 %	20.20 %	15.80 %	1.20 %	1.50 %	0	0	0	0

(as in hospitals with higher levels of care) is correlated with reduced mortality rates,<sup>6-7</sup> suggesting enhanced skills through regular practice. However, in Austria, the majority of newborns are low-risk infants born in hospitals with levels I or II (64.5 % of all births), and only 42.6 % of medical staff felt sufficiently prepared for neonatal emergency events.

The ERC NLS guidelines clearly emphasise the need for competent personnel in newborn life support to be present at every delivery. Additionally, 'a process should be in place for rapidly mobilizing a team with sufficient resuscitation skills for any birth'.<sup>2</sup> Our data indicate that this requirement is not consistently met in Austria.

To the best of our knowledge, no comparable data are available for either high- or low-income countries. Acquiring such data could facilitate comparisons and development of appropriate measures to ensure optimal preparation for newborn emergencies.

#### Subjective self-assessment: FMV

In most non-vigorous newborns, effective FMV alone is usually sufficient to improve their condition. However, FMV can be challenging for attending teams, especially during unexpected emergencies or when they are not adequately equipped or trained. The finding that one-third of all survey respondents assessed themselves as having insufficient newborn FMV skills is alarming. The positivity rates were higher in hospitals that provided a higher level of care (90.2 % in level IV). However, as highlighted earlier, with 64.5 % of all births in Austria occurring in level I/II hospitals, only approximately half of these births are attended by someone confident in their ability to ventilate newborns.

A previous study by our research group highlighted the importance of FMV training. By introducing regular newborn resuscitation training, the number of newborns requiring chest compressions significantly decreased.<sup>8</sup> Wagner et al. analysed the availability of training in

paediatric and neonatal institutions in German-speaking countries<sup>9</sup> They found that only 61.4 % of the institutions reported regular training sessions. These data correspond well with our findings that a significant proportion of healthcare providers in neonatal facilities feel insufficiently skilled for newborn FMV.

Beyond the simple 'yes' or 'no' questions of whether training was conducted, we must consider the necessary frequency and quality of training. A recent manikin study indicated that a minimum of six training sessions within 9 months (every 4 weeks) is required to ensure an optimal mask seal for newborn ventilation. Additionally, at least two sessions within 9 months (every 4.5 months) are needed to maintain airway patency.<sup>10</sup> While further studies are warranted to identify the optimal training frequency, the results of our survey indicate that the current status of healthcare provider training in Austria is insufficient.

Nevertheless, it is crucial to note that the individual self-assessment tool used in this study may not completely reflect real-life ventilation skills. Acknowledging the potential bias, our data must be interpreted carefully.

#### Face mask ventilation as the first method

Most respondents chose FMV as the primary ventilation method for newborns immediately after birth (98.1 %). This finding aligns with those of previously published studies.<sup>11-12</sup> In Austria, a shift from the use of round facemasks towards anatomically shaped facemasks with air rims (predominantly used; 74.9 % in our study) has been observed. We did not find any international comparative studies on the use of different types of face masks.

#### Laryngeal mask ventilation

Recently, supraglottic airway devices have attracted considerable



attention.<sup>13–16</sup> They are valuable rescue devices in term newborns, especially if FMV and ETI are unsuccessful or unfeasible.<sup>2</sup> However, LMA are often unavailable, and a lack of training hampers their wider application in neonatal resuscitation,<sup>17–19</sup> which was confirmed in our study.

## ETI

The ERC newborn life support guidelines recommend using ETI on a newborn when chest compressions are required.<sup>2</sup> However, ETI is a rare event and is performed less frequently owing to increased strategies for non-invasive ventilation in neonatal care, leading to a decline in ETI expertise<sup>20–23</sup> Therefore, we hypothesised that ETI may not be easily performed, especially in hospitals with lower care levels.

According to our results, hospitals with higher care levels reported greater confidence in ETI. However, in 61.3 % of hospitals or 52.5 % of all births in Austria, safe ETI may not always be provided. This number is likely to be even higher, as 16 hospitals (primarily lower-level care hospitals) in Austria were not represented in this survey.

Thus, inexperienced or insecure professionals may need to perform intubation in high-acuity situations. Lower ETI experience is associated with an increase in intubation attempts<sup>24</sup> and low first-pass success rates, even in perinatal centres.<sup>25–26</sup> Every additional intubation attempt increases the risk of adverse events, neonatal morbidity, and mortality.<sup>25,27–29</sup>

The indications for and optimal timing of ETI during neonatal resuscitation remain unclear. However, given that a relevant percentage of teams will not be able to safely provide ETI for newborn resuscitation (at least in Austria, a high-income country), this finding might be valuable. Remarkably, this is also reflected by our survey, as 80.0 % of respondents in the airway group opposed intubation prior to chest compressions (provided mask ventilation is effective) and would perform ETI only after venous access and medication were established.

Therefore, the results of this study may have implications for future guidelines on newborn resuscitation, particularly when considering circumstances (especially in hospitals with lower care levels) and the timing of intubation.

Based on these data and previous studies showing that the first-pass success rate for ETI is low, even in perinatal centres,<sup>25–26</sup> the following question arises: How can ETI skills be improved? Respondents cited a lack of experience and insufficient training opportunities as barriers to effective ETI. This might be partially addressed through rotations in paediatric anaesthesia departments and frequent, regular training sessions. The issue of limited visibility during neonatal intubation might be improved using video laryngoscopy, as published data have demonstrated its positive effect on the first-pass success rate.<sup>26,30</sup> Furthermore, nasal high-flow during the attempt,<sup>31</sup> intubation checklists and pre-medication sets should be mentioned to mitigate tracheal intubation-associated events in neonatal emergencies.<sup>21,32</sup>

Despite efforts in education, training, and equipment optimization for ETI, we assume that it is unrealistic to expect continuous safe newborn intubation 24/7 in hospitals with lower levels of care. Therefore, it is essential to optimise the FMV, for example, by constantly training the FMV and adhering to mnemonics, such as MRSOPA.<sup>33</sup>

## Laryngeal mask ventilation

As discussed above, supraglottic airway devices are valuable rescue devices in term newborns, especially if FMV and ETI are unsuccessful (cannot ventilate or intubate). We found that LMA were rarely used for neonatal resuscitation in Austrian hospitals. In the airway group, only 12.2 % rated themselves as proficient in LMA (mainly anaesthesiologists), and only 6.1 % applied LMA to newborns more than 10 times. It is advisable to incorporate the assumingly easy-to-learn technique of LMA into regular training sessions to increase its utilisation and allow for another viable option in airway management. Further studies are

required to evaluate the use of LMA, particularly during emergencies.

## Limitations

This study had several limitations. The number of respondents was unevenly distributed across hospitals, which could have led to over- or under-representation of certain hospitals and levels of care. Furthermore, the exact response rate cannot be established due to the unknown total number of questionnaire recipients. Survey distribution via the individual heads of departments may have introduced a potential selection bias. We did not describe the collective opinions of individual departments but aimed to present an overall, albeit subjective, picture of the skills and emergency preparedness of Austrian neonatal healthcare providers. Furthermore, the survey aimed to capture individual opinions, without comparing self-rated skills with actual skills.

## Conclusion

According to our data, a significant proportion of healthcare providers in Austria do not feel optimally prepared for neonatal emergencies, and safe intubation is not guaranteed at all times in more than 60 % of hospitals. This applies in particular to hospitals with lower level of care. Additional data from other nations are warranted for comparison and to provide recommendations for nationwide resuscitation guidelines.

## CRediT authorship contribution statement

**Eva M. Schwindt:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Conceptualization. **Reinhold Stockenhuber:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jens Christian Schwindt:** Writing – review & editing, Supervision, Methodology.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Eva M. Schwindt reports a relationship with SIMCharacters Training GmbH that includes: board membership, employment, equity or stocks, and speaking and lecture fees. Jens Christian Schwindt reports a relationship with SIMCharacters Training GmbH that includes: board membership, employment, and speaking and lecture fees. Reinhold Stockenhuber reports a relationship with SIMCharacters Training GmbH that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.resplu.2024.100817>.

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